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SMILE

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SUSTAINABLE MOBILITY SCENARIOS

CITY OF ZRENJANIN

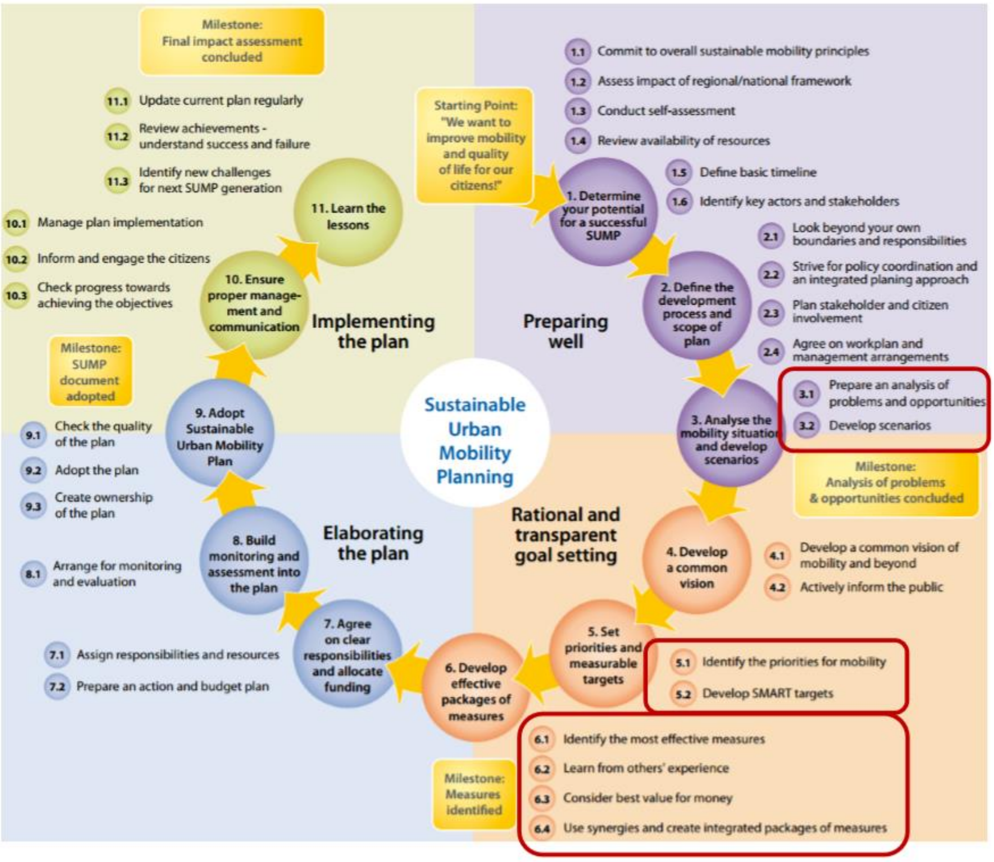
1. Overview of the Urban Transport Roadmaps Tool

Cities in Europe are vital centers of economic activity, innovation and employment. However, they face increasing challenges to their mobility systems such as congestion, air pollution, ambient noise, CO2 emissions, accidents and urban sprawl. To tackle these problems cities, need to develop and implement coherent and challenging Sustainable Urban Mobility Plans (SUMP).

The Urban Transport Roadmaps project provides on-line tool to help develop the first scenarios of SUMP. With its simplified approach the tool serves as a first step and allows:

- to explore and identify appropriate sustainable transport policy measures;
- to quantify the transport, environmental and economic impacts of these measures;
- to consider an implementation pathway (roadmap) for the policy scenario.

The roadmaps tool is focused on developing the overall goals, approach and basic policies packages that form the basis of a SUMP before further elaboration and implementation. This relationship is illustrated in Figure 1 below.[1]



Key: = action supported by this study

Figure 1. *Overview of how the tool interacts with the SUMPs process [1]*

[1]Study On European Urban Transport Roadmaps 2030, Tool description and user guide, March 2016, D.Fiorello, F.Fermi, G.Hitchcock, D.Clarke

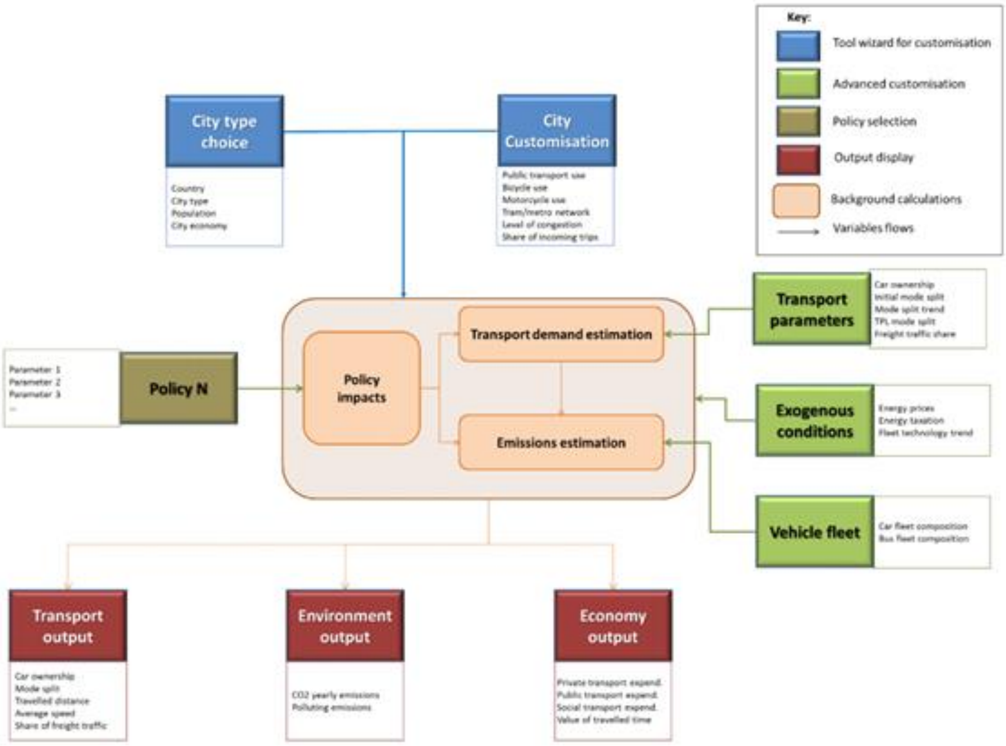
Tool is designed to carry out initial scoping of potential policies that could be applied to a city. It allows single policies and groups of policies to be assessed providing estimates of the impact on a range of transport, environment and economic indicators. The tool has five main structural elements[2]:

- The City Wizard – this is the main entry point of the tool and allows the user to select some basic information to characterize city. This basic information allows the model to set up the most appropriate basic transport patterns to represent the city, providing a simple and quick initial configuration of the model.
- Advanced Settings – for the more advanced user there is the ability to customize the default data, using local data, to provide a more accurate representation of the city.
- Policy selection – having selected a city type, and potentially customized it, the user can then select various policies to apply in their city. The primary policy measures will be associated with default parameters.
    - Policy customization – as with the city types the default data for the policy options can be customized to refine the policy measure.
- Calculation framework – this forms the core of the tool and takes the city setup parameters and policy measure parameters to calculate the results for the policy measures in the selected city. The calculation framework comprises three key elements:
    - The transport module - that calculates the base transport patterns for the city and then adjusts them in relation to the policies.
    - The emissions module - that calculates the emissions and environmental data associated with the transport activity.
    - The policy modules - that translates the policies into impacts.
- Tool outputs – these provide the numerical and graphical representations of the impacts of the transport policies on the city. There are three main types of impact that are generated by the tool:
    - Transport impacts – including mode share, average trip distances and traffic levels;
    - Environment outputs – covering CO2, CO, PM, NOx and VOC emissions, and accident rates;
    - Economic outputs – providing the direct cost/benefits associated with the policies, and the social cost of emissions and accidents.

This tool serves to define mobility scenarios targeting the cities of the 28 EU Member States as well as Norway and Switzerland. As Serbia strives towards the European Union, and has similar socio - economic circumstances is possible to select this tool to create scenarios of mobility in the city of Zrenjanin.

[2]Study On European Urban Transport Roadmaps 2030, Tool description and user guide, March 2016, D.Fiorello, F.Fermi, G.Hitchcock, D.Clarke

Illustration of calculation framework



The variables describing urban mobility are calculated annually between the years 2015 and 2030 on a yearly basis. The basic development of the annual trends is the result of exogenous trends and of the interactions between the variables. These interactions are managed by means of parameters. Initially a reference trend of the urban mobility and of its effects is computed based on the set up defined by the user in the city wizard. This trend can be affected by policy measures. The conditions of urban mobility and its impacts are then summarized by several indicators which are also used to assess the impact of policy measures. [3]

The core of the calculation framework consists of:

• The transport demand calculation module which is a basic strategic transport model at the city scale;

• The policy impact modules that estimate the impact of policies on key transport parameters;

• The emissions calculation module the city wizard modules provide the initial configuration parameters that are used to set up the transport and emissions modules. The advanced settings module then allows further adjustment of key parameters in the transport and emissions modules. The policy module allows for the implementation and configuration of policies and how these affect the core transport and emissions modules. These core modules then generate the transport, environment and economic outputs that are displayed in the tool. This framework is illustrated in figure above.

[3]Study On European Urban Transport Roadmaps 2030, Tool description and user guide, March 2016, D.Fiorello, F.Fermi, G.Hitchcock, D.Clarke

The first step of project is based on a questionnaire previously submitted to all PPs in order to obtain some essential information needed for the elaboration of mobility scenarios.

After data collecting, the next step is to enter socio-economic data on Zrenjanin into the tool (application). These are data on the characteristics of the traffic system of the city (modal split - participation of modes of transport in total traffic, development of public transport, statistics on the number of registered motor vehicles in Zrenjanin and others).

The application then generates mobility scenarios on the basis of the entered data and gives graphic representations of certain situations. The application has the option of defining traffic flow forecasts, as well as the Modal Split.

From the aspect of the Transport System, Zrenjanin faces a number of problems related to a characteristic decline in the number of inhabitants year after year, accompanied by an increasing number of passenger cars. Also, the problem is the fact that is present a small occupancy rates of passenger cars (app. 1.7).The large share of passenger cars in the overall mode share, followed by a large number of trips by this mode, from which the largest number of trips are for the purpose of going to work (particularly to industrial zone).All this eventually leads to congestion in the central part of the city that is created by local movements and transit traffic.

The main problem that the city of Zrenjanin has, in addition to mixing local and transit traffic, is the lack of bypass, as well as many modes of transport and a large amount of transport on a small area of the city, which in turn has a low level of traffic safety.

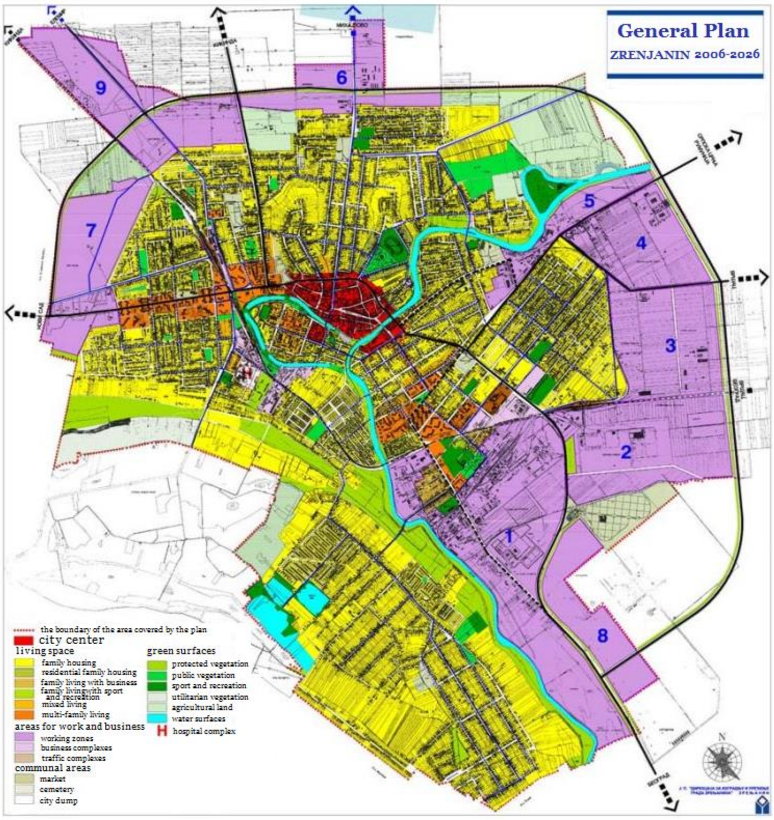


Figure 2. Map from General plan of Zrenjanin with land use (SOURCE: http://www.zrenjanin.rs)

City of Zrenjanin plans a construction of the bypass around the City. This is a project of great importance to the City, because it would be a way of relocating transit traffic from the central city zone, which would significantly improve the conditions of urban traffic. Position of the bypass is shown on figure below (Figure 3).

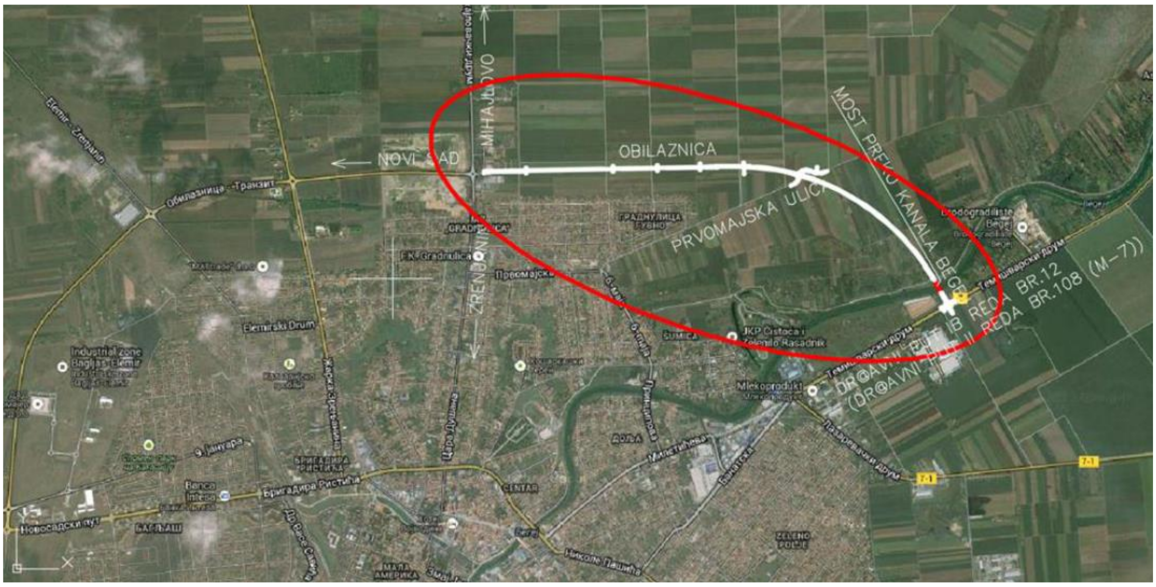


Figure 3. Planned continuation of the construction of the bypass Zrenjanin

Figure 4. View of intersection in Zrenjanin near city center with a large number of freight vehicles

The significance of the construction of the bypass will be more obvious by its impact on State road IB, through which most of the city's public passenger transport routes are currently undergoing.

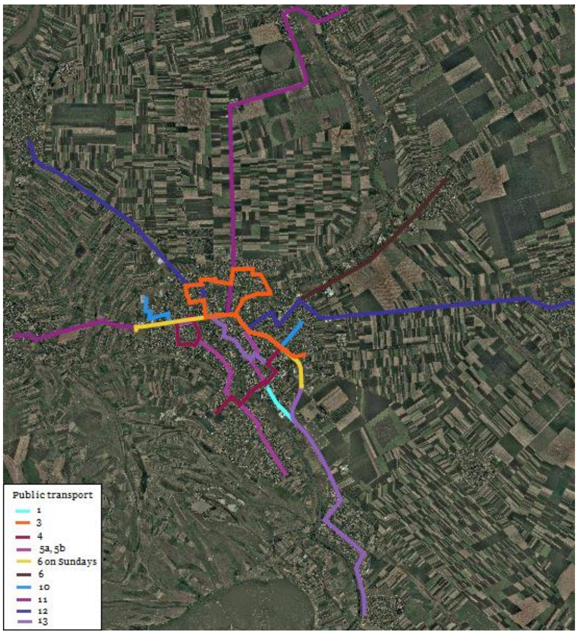


Figure 5. Position of Public transport lines throws the City of Zrenjanin (SOURCE: GIS portal Zrenjanin)

Bearing in mind all the problems in the transportation system of the city of Zrenjanin, for this purpose, three scenarios have been defined, as required in the Project Task.

The first is the **Pessimistic scenario**, where there is no investment in the transport infrastructure, where the bypass will not be built, an increase in traffic is foreseen due to increase of the traffic volume on State roads due to the development of the state of Serbia at the regional level and the development of industry in the City of Zrenjanin. There is small development of cycling but not sufficiently.

The second is the **Moderate scenario**, which foresees the construction of the bypass and the measure of prioritizing public transport which will affect a development of a public transport system for passengers, where there is no characteristic increase in passenger car traffic due to traffic relocation. Because of predicted measures on improving public transport system for passengers it is predicted decrease in

The third is the **Optimistic scenario**, which, in addition to the measures included in the moderate scenario (construction of the bypass and the measure of prioritizing public transport), includes and implementation of a number of measures that will be described below.

Based on these data, the application exposes data on possible network congestion, air pollution by the traffic system, economic costs.

The scenarios defined to improve the sustainability of urban transport consist of the implementation of various policy measures. Policy measures are the elementary components that are used for defining the roadmaps that will be described later. A

wide range of policy measures exist that are potentially useful for setting up urban strategies aimed at addressing transport sustainability.
From this long list of measures a set of key policy measures was identified based on criteria including:

- Policy type (i.e. demand management; green fleets; infrastructure investment; pricing and financial incentives; and traffic management/control);
- Institutional level of implementation (i.e. by national or local authorities);
- Effectiveness on key impact areas, cost distribution, and transport modes covered.

A policy initiative is expected to select some of the potential measures and to combine them in order to define a realistic policy scenario.
In the initial conditions the city has some congestion and pollution problems despite a good level of coverage of public transport. Cars are often used when alternatives are available because many individuals are not used to travelling by public transport and do not have a clear perception of its level of service while the car can be used basically everywhere. The policy effort starts with the implementation of short-term measures and with the design of more complex measures. In order to promote other sustainable mobility solutions (not only public transport) a plan is prepared for building a network of cycling lanes and pedestrian paths. Streets where these facilities should be introduced are selected taking into account traffic calming interventions and traffic restrictions defined with other measures.
In table below (*Table 1*) the socio-economic data required as an input parameter of the tool are shown. With the help of a tool, when entering these data, it is allowed to build up profile of Zrenjanin.
It starts with some basic information about the city such as city type, population size, name of country, population trend, basic economic data. Next step is further customization of the tool to be applied to Zrenjanin.

Table 1.*Socio - economic data on Zrenjanin that are necessary for launching the tool*

Context	Indicator	Value
City	City type	Medium city (100.000-500.000 inh.)
	Population	123,362 inhabitants
	Country	Serbia (same socio-economic circumstances as Croatia)
	Population trend	Limited decline: growth rate of -0.5% per year
	Sprawling trend	Some sprawl
	City economy	Relevant industrial sector
	Income	Medium average income per capita
Mobility	Mode split of internal mobility	Pedestrian 30.9% Bike 1.7% Motorbike 0.9%

		Car 47.4% Bus 19.1%
	Parking fare	0.33 euro / h
	Parking regulation	Mix of parking lots are charged
	Public transport reserved lanes	Reserved lanes for bus/tram do not exist or are negligible - Less than 5% of the public transport network length consists of reserved lanes.
	Cycling reserved lanes	An extensive network of bike reserved paths exists - Bike reserved lanes length is 8% or more of the road network length.
	Car sharing service	Not available
	Park & ride service	Not available

Data sources[4]

It is worth considering that the strategic nature of the tool and the need for a flexible structure that can be customized to meet the needs of a large number of urban areas made challenging the task of populating the calculation framework with data. Many elements required in the calculation framework are context specific. Examples are the average trip distance by mode, the trip distribution between peaks and off-peak periods, but there are many others. Also, the impacts of policy measures are highly context-sensitive as the implementation under real-world conditions is important. Furthermore, the aggregated level of the tool required to quantify the impacts of changes in transport demand at a very general level which is not necessarily what can be found in the research literature. Finally, many initial elements of the model, but also several elasticity parameters that influence policy impacts are not locked and hidden in the model structure but available for users' adaptations. What is needed for these elements is not an exact value, but rather a plausible starting point. All these aspects mean that the data set for the tool is a combination of robust literature-based parameters (e.g. emissions factors), generalizations of data based on case studies and estimates based on professional judgment when needed.
Therefore, the parameters driving the calculation framework (including the impacts of the policies) have been estimated on the basis of a wide range of data sources: travel surveys, Eurostat database, national statistics, modelling source (e.g. ASTRA-EC model, TREMOVE model), policy focused researches, professional literature, project reports, urban traffic studies, conference papers. As an example, about 70 different documents were used as a reference to estimate the parameters driving the impacts of the policies. Furthermore, whenever possible and meaningful, parameters were

[4] Claudia de Stasio et al. / Transportation Research Procedia 14 (2016) 3189 – 3198

differentiated by countries (e.g. car ownership, PT production costs by mode, energy mix for electricity generation, vehicle fleet composition, etc.).
With reference to the exogenous assumptions related to technology, energy and national taxation trends, the quantification of projections was defined based on recent studies, such as e.g. European Commissions (2013), Krail et. al. (2014), Fiorello et. al. (2012).

2. Pessimistic scenario

Zrenjanin is a city suitable for the development of pedestrian and bicycle traffic, however, these types, as well as public transport in the city are something that was not sufficiently used in Zrenjanin. The pessimistic scenario shows the consequences that will occur if there is no development of cycling or other alternative forms of traffic. Also, as mentioned above, there will not be the bypass construction.

Figure 6 shows ratio between cars and thousand inhabitants per years for pessimistic scenario. This tool allows traffic flow forecasts until 2030.

The tool use impact on car ownership simulated at EU level in the HOP! Project (Macro-economic impact of High Oil Prices) (2008) as a reference to estimate the alternative trend.

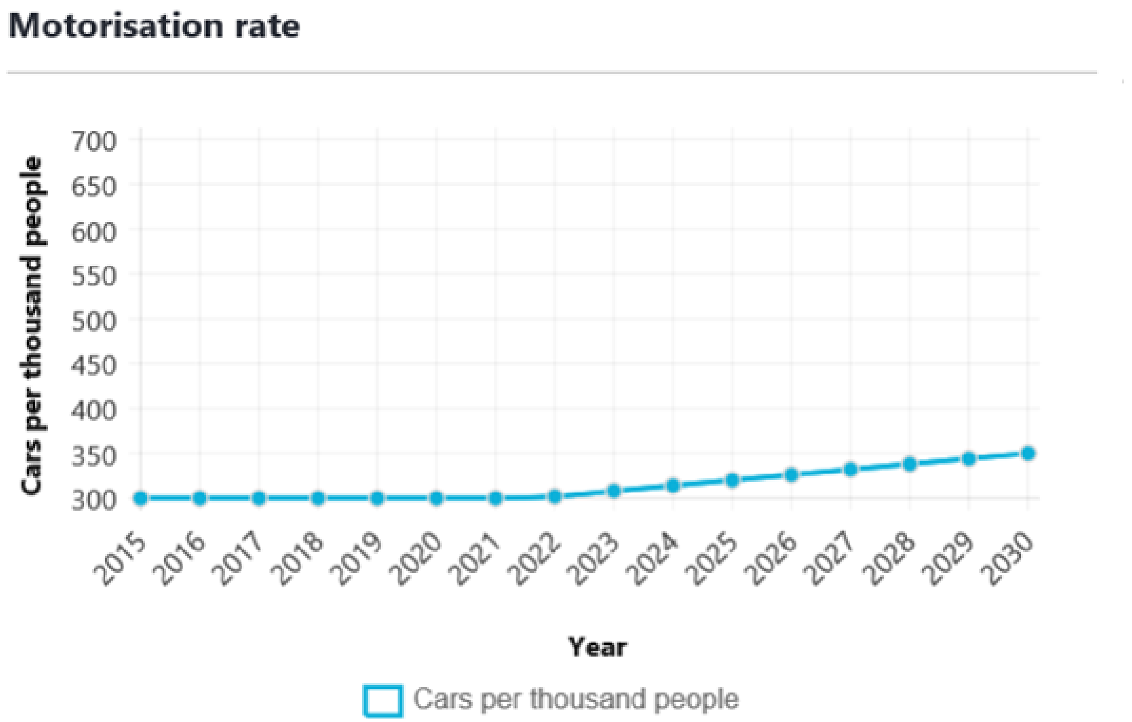


Figure 6. *Motorization rate, in terms of ratio between cars and thousand inhabitants per years for pessimistic scenario*

From figure above (*Figure 6*) it is noted that in **2017** the number of passenger cars per 1000 inhabitants is 272 (which is measured value inserted in a tool), while the forecasted number in **2020** is 290, and in **2030** is 350 passenger cars. This is an increase in motorization of 28.7% in just 13 years.

The input required is the share of trips made with each of the available alternatives: car, motorbike, bikes, pedestrian, public transport. An initial value is provided based on the data collected by the research. The total sum of the shares had to be 100%. Even without any policy intervention, the use of transport modes changes over time. This input allows the tool updating the mode shares of the base year according to either observed or expected trend. The input is focused on the role of car for urban mobility.

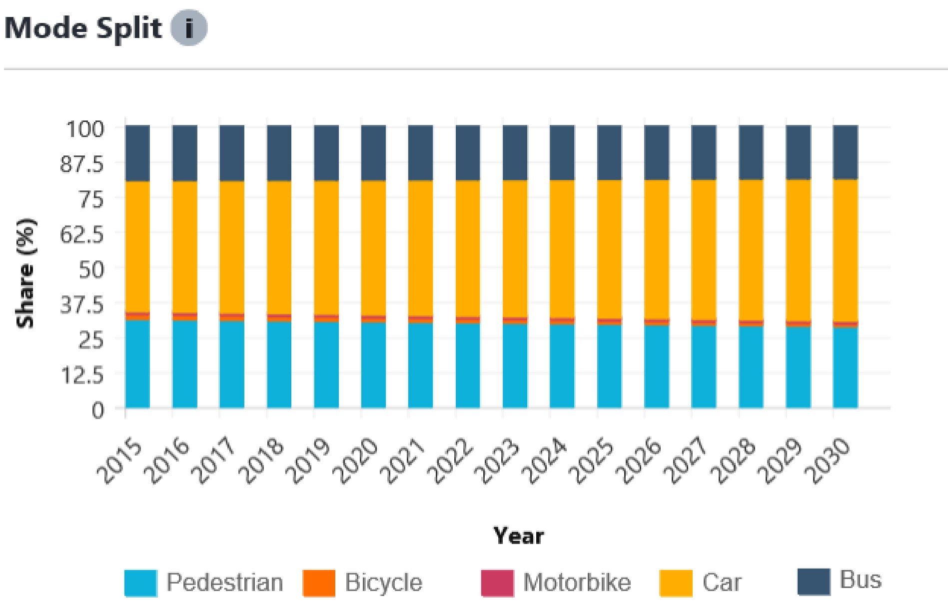


Figure 7. *Percentage share of each mode of transport per years for pessimistic scenario*

From Figure 7 it is noticeable that in **2017** the largest share in modes of transport is by passenger cars as well as in all foreseen years. If the situation is as it is up to now, without certain measures to improve the conditions for sustainable modes of transport, it is projected that in **2020** the percentage of pedestrians will be 30.39%, cyclists 1.53%, motorists 0.91% cars 48.17% and buses 18.99%, which is an increase in the number of passenger cars and a decrease in the number of pedestrians, cyclists and the use of public transport. It is even more noticeable that a number are getting worse in forecasted **2030**, when it is predicted that the percentage of pedestrians will be 28.64%, cyclists 1.04%, motorists 0.89% cars 50.9% and buses 18.54%.
The average car fuel consumption is assumed to improve at double speed than in the reference scenario. The improvement rate for gasoline, diesel, CNG and LPG vehicles is therefore about -2.6 / -3.0 % per year, while for innovative vehicles a growth rate of

about -0.8 % / -1% per year is implemented (Source: Study on Urban Transport Roadmaps 2030).

The tool also provides an overview of current and predicted fuel consumption by type. It is noticeable that this pace will drastically increase the consumption of diesel fuel as well as gasoline. Forecasts are in the pessimistic scenario that diesel consumption will increase by more than 3 times by 2030, and gasoline for more than 2 times. In **2017**, the consumption of the diesel is 49940 tons per year, gasoline 20623.9 and hydrogen 0.065. In **2020**. the consumption of the diesel will be83731.9tons per year, gasoline 27267.9 and hydrogen 0.123. In **2030**. the consumption of the diesel will be 181347.4 tons per year, gasoline 45745.5 and hydrogen 12.86 (*Figure 8*).

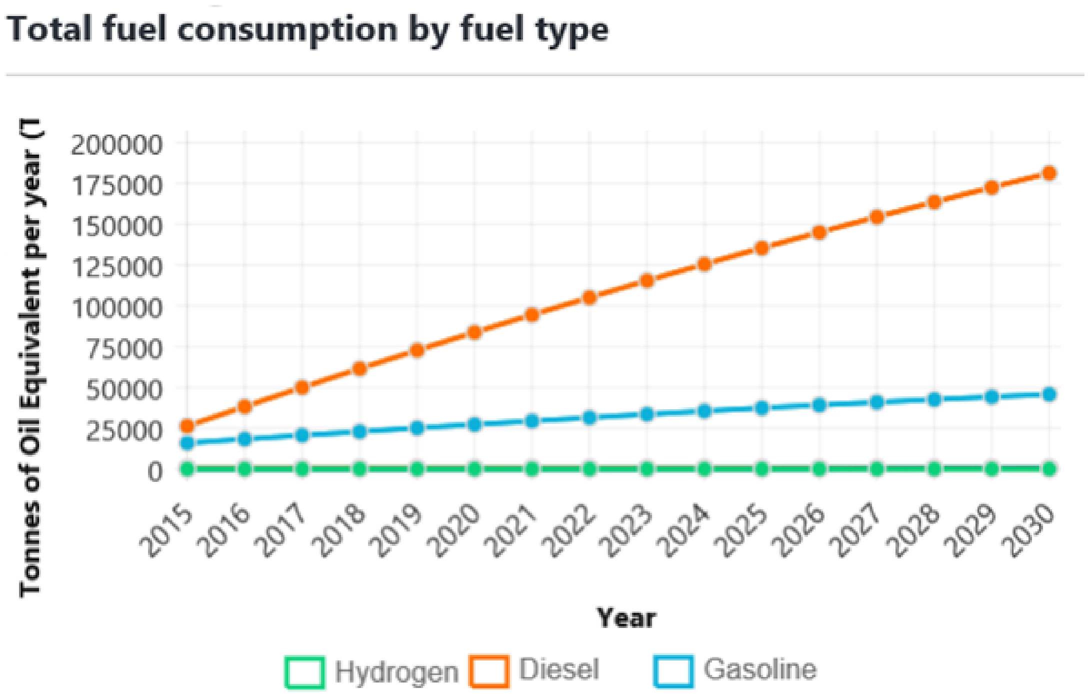


Figure 8. *Total yearly transport fuel consumption by fuel type (both internal mobility and incoming trips are considered) per years for pessimistic scenario*

It's becoming more and more apparent how much the harmful impact of CO_2 emissions actually is. By doing nothing predictions are that a huge increase in quantity of CO_2 will occur. In **2017**, emission of CO_2 is 219295.4 tons, in **2020**, emission of CO_2 will be 343427.8 tons and by **2030**, emission of CO_2 will be 701159.9 tons which is 68.7% more than in 2017. The CO_2 emission increase graph is shown below in figure 9.

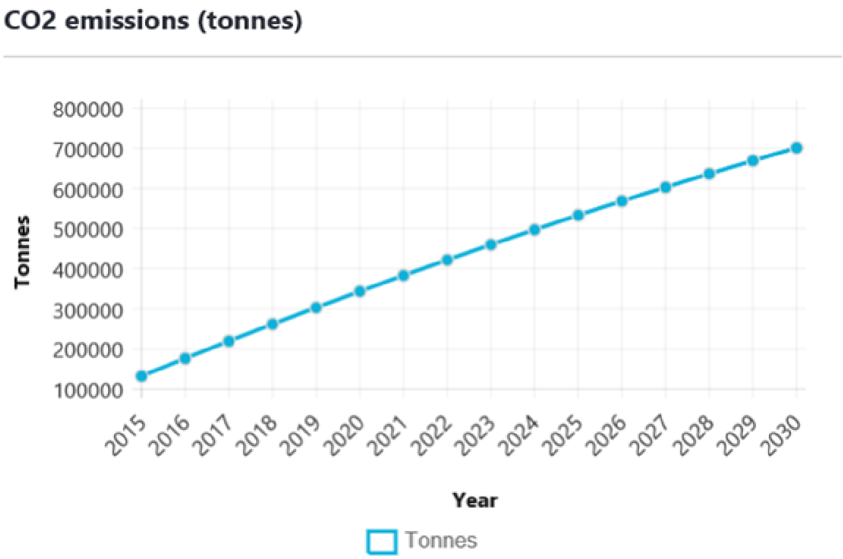


Figure 9. *Transport yearly CO2 emissions in pessimistic scenario*

3. Moderate scenario

The moderate scenario takes into account the construction of the bypass around Zrenjanin (Planned route of the bypass in Zrenjanin is shown in Figure 3. on this design) with whose construction the route of the state road IB No.13 will become a street road. This measure aims at relocating complete transit traffic outside the area of the city. Since the State Road IB No. 13 is the hub of most public passenger transport lines and has two separate pavement lanes, this scenario envisages further improvement of this mode of transport by marking a yellow bus lane along the entire section (app 6km). The planned bus lane links the Industrial Zone with the city center.

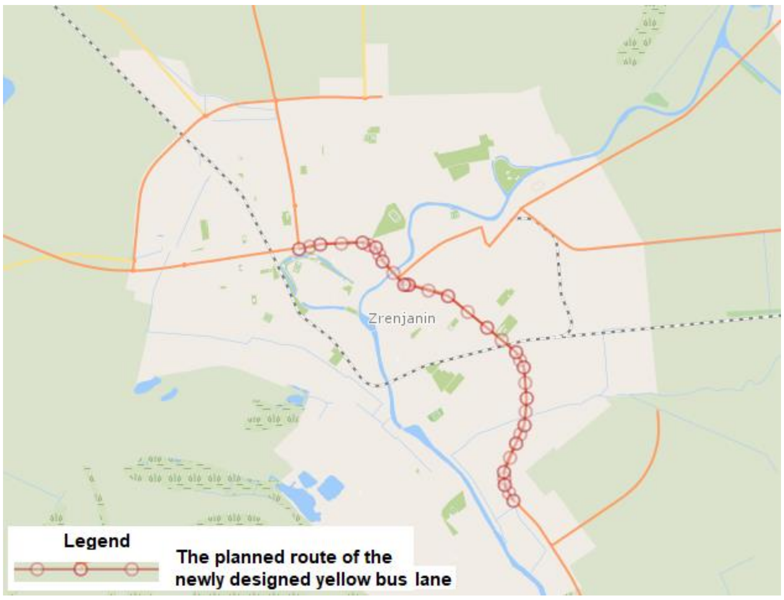


Figure 9. The planned route of the newly designed yellow bus lane

Figure 10. Section on State road IB no.13 in Zrenjanin on which the marking of the yellow lane for the buses is planned

Figure 11. Bus lane in New York City
(Source: https://www1.nyc.gov/html/brt/html/home/home.shtml)

Figure 12. Yellow lane in Belgrade

For the purpose of creating a moderate scenario for Zrenjanin, policy measures are chosen on base of collected data, local knowledge of socio - economic data, transportation system.

Selected measures are:

- Bus network - Redesigning the network layout of public transport by extending the service as well as by improving bus stops, stations, etc.
- Prioritizing public transport - Improving the service reliability and attractiveness to the general public, mainly by priority lanes.

The selected group of measures is aimed at promoting and popularizing pedestrian and the use of public transport which are currently insufficiently used in Zrenjanin.
When choosing policy measure of prioritizing public transport, for initial year of the measure is planned 2022 with 2-year period for implementation and designed length of bus reserved lane 6km.

Figure 13 shows ratio between cars and thousand inhabitants per years for moderate scenario. As a reference for estimation the alternative trend, the tool use impact on car ownership simulated at EU level in the HOP! Project (Macro-economic impact of High Oil Prices) (2008).

This tool allows traffic flow forecasts until 2030. On figure (*Figure 13*) there are two lines; one (darker) represents the values in moderate scenario while the other represents the values in basic - pessimistic scenario. It is noted that the motorization rate for **2017** is 245, while the forecasted number in **2020** is 253, and in **2030** is 298 passenger cars per 1000 inhabitants.

Observing this scenario in relation to the base - pessimistic scenario, there is a significantly lower motorization rate. If specific measures were implemented in the moderate scenario, the expected motorization rate in 2030 would be 14.9% lower than for the same period in the pessimistic scenario.

Although passenger car participation in Modal Split is reduced, it can be expected that with the rise in population standards, the motorization rate will increase, bearing in mind that the Republic of Serbia is in the process of economic development. This should not be understood in such a way that residents of Zrenjanin will use passenger car for the purpose of moving around the city (the purpose of going to work or some other), but for the purpose of leaving the city for a weekend, on vacation or for other purposes not related to basic purposes movements in the urban area. This is in accordance with the statistics of development of Motorization Rate in the European Union. A graph showing the motorization rate in the EU for the period 1990-2016 is given below (source: https://www.statista.com/statistics/452238/europe-eu-28-number-of-cars-per-1000-inhabitants/).

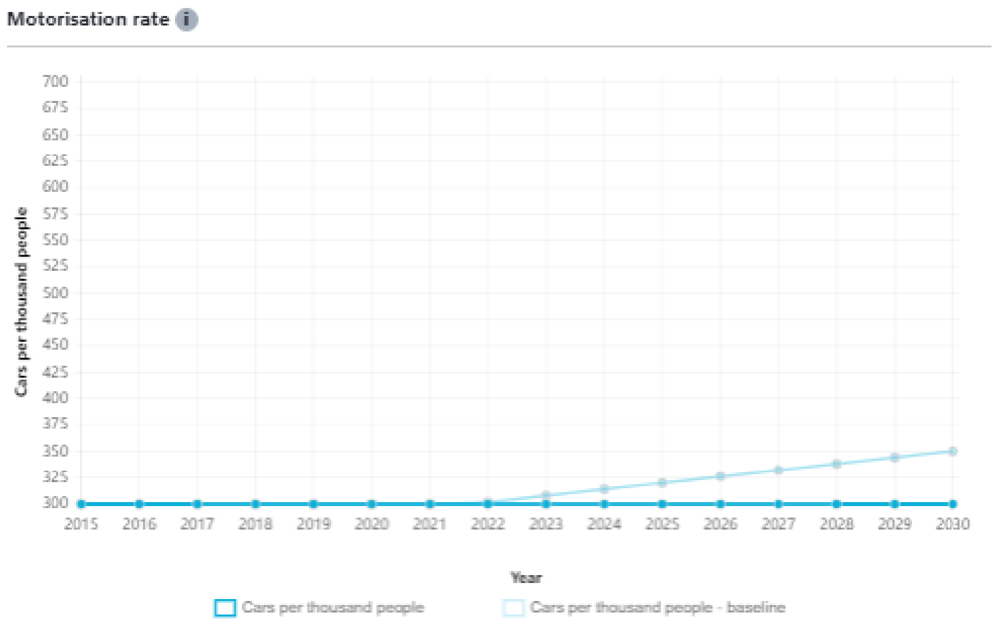


Figure 13. *Motorization rate, in terms of ratio between cars and thousand inhabitants per years for moderate scenario*

From Figure 14 it is noticeable that in **2017** the largest share in modes of transport is by passenger cars as well as in all foreseen years. Projections are that in **2020** the percentage of pedestrians will be 28.6%, cyclists 3.6%, motorists 1.2% cars 35.9% and buses 30.8%, which is a significant improvement in the use of public transport. It is even more noticeable that number are getting better in forecasted **2030**, when it is predicted that the percentage of pedestrians will be 28.6%, cyclists 7.4%, motorists 0.6% cars 29.8% and buses 33.6%.

In this scenario, it is envisaged that by 2030, percentage in the use of public transport will increase by 6% at the expense of reducing the number of passenger cars by 10.1%.

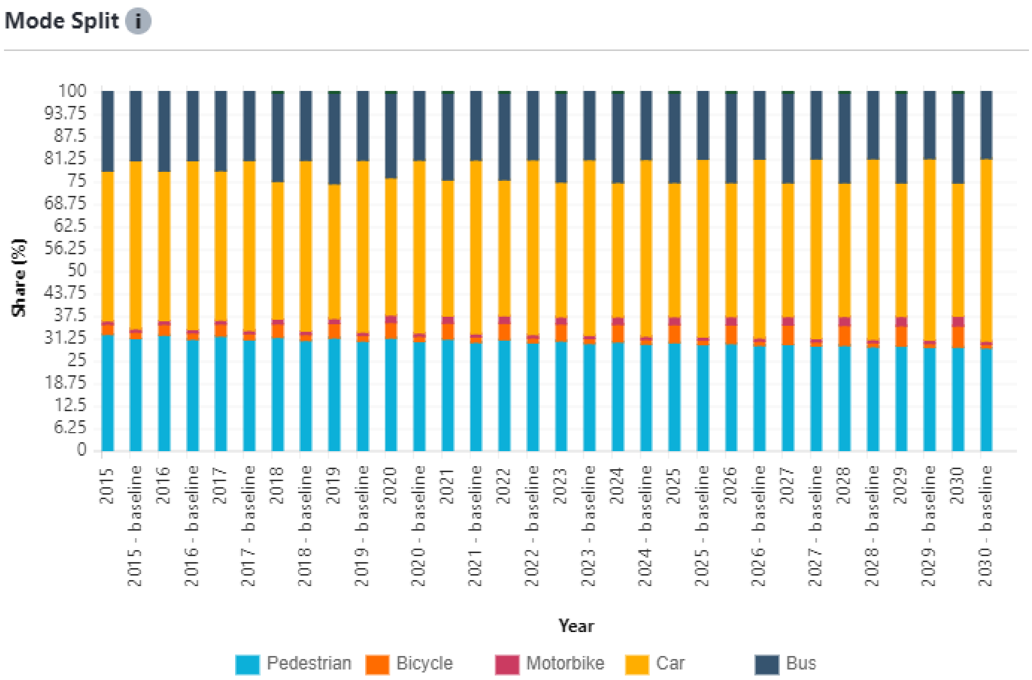


Figure 14. *Percentage share of each mode of transport per years for moderate scenario*

An overview of current and predicted fuel consumption by type for moderate scenario is shown in figure 15. It is noticeable that, with the application of a minimum number of measures, decrease of the consumption of diesel fuel as well as gasoline shall occur in according to base year (pessimistic scenario). Forecasts are that in **2017**, the consumption of the diesel is 10354.9 tons per year, gasoline 11466.0 and hydrogen 0.060. In **2020**. the consumption of the diesel will be 9247.7 tons per year, gasoline 10408.9 and hydrogen 0.108. In **2030**. the consumption of the diesel will be 6310.4 tons per year, gasoline 8136.6 and hydrogen 10.1 (*Figure 15*).

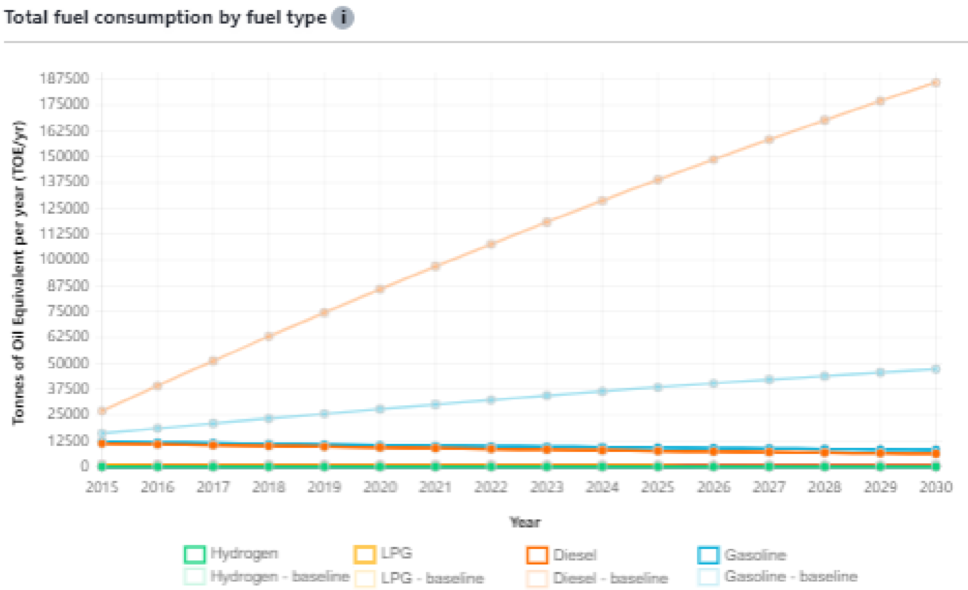


Figure 15. *Total yearly transport fuel consumption by fuel type (both internal mobility and incoming trips are considered) per years for moderate scenario*

All this leads to data about predictions of CO_2. In **2017**, emission of CO_2 is 69581.2 tons, in **2020**, emission of CO_2 will be 62682.1 tons and by **2030**, emission of CO_2 will be 45991.1 tons. The CO2 emission increase graph is shown below in figure 9and shows the values for a moderate scenario (darker color) and a basic - pessimistic scenario (brighter color).

In this scenario, it is predicted that by 2030, emission of CO_2 will decrease by 23590.1 tons, compared to 2017 year. Savings in emission, relative to the one that would be in the pessimistic scenario, for 2030 year is 673553.8 tons (Figure 16).

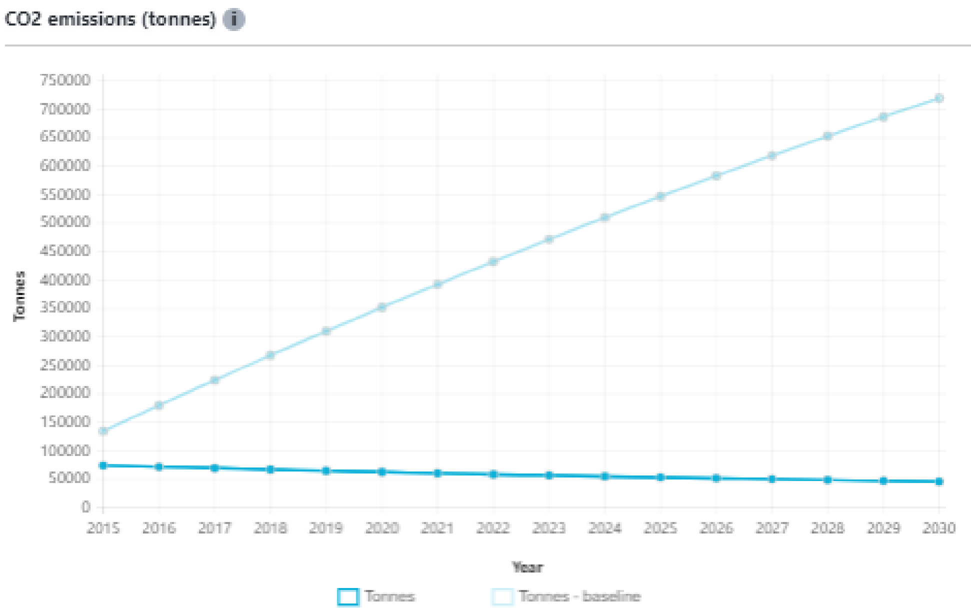


Figure 16. *Transport yearly CO2 emissions in moderate scenario*

4. Optimistic scenario

This scenario envisages implementation of various policy measures.

The tool possesses a wide range of policy measures that are potentially useful for setting up urban strategies aimed at addressing transport sustainability. Sources such as the ELTIS, CIVITAS and EPOMM websites provide a wide range of examples of individual actions to promote sustainable mobility. These existing catalogues of solutions and best practice formed the basis for developing a prioritized set of policy measures. A long list of policy measures was identified from these sources by clustering the actions into broader measures. From this long list of measures a short-listed set of key generic policy measures was identified. The short-list comprised the 19 policy measures that can be selected in the tool.[5]

For the purpose of creating an optimistic scenario for Zrenjanin policy measures are chosen on base of collected data, local knowledge of socio - economic data, transportation system. This scenario involves the implementation of measures that appear in the moderate scenario, related to construction of the bypass around Zrenjanin and building a yellow strip along the entire section (of State road IB no.13) for buses only. The planned bus lane links the Industrial Zone with the city center, with an additional package of measures that will be aimed at improving pedestrian and bicycle traffic in Zrenjanin.

One of the measures to improve the bicycle as a mode of transport is the construction of bicycle lanes on the state road IB of the order no. 13, which is being provided along with yellow lane for buses, but also the construction of new bicycle lanes that will connect industrial zones to the city center, as well as to make entirety and good connectivity so that the bike becomes more attractive and more accessible mode of transport. On figure 17 is shown a planned location of new bike lanes in total length of 9.6 km.

[5]Study On European Urban Transport Roadmaps 2030, Urban transport policy roadmaps, March 2016, C.de Stasio, D.Fiorello, F. Fermi, G.Hitchcock, S.Kollamthodi

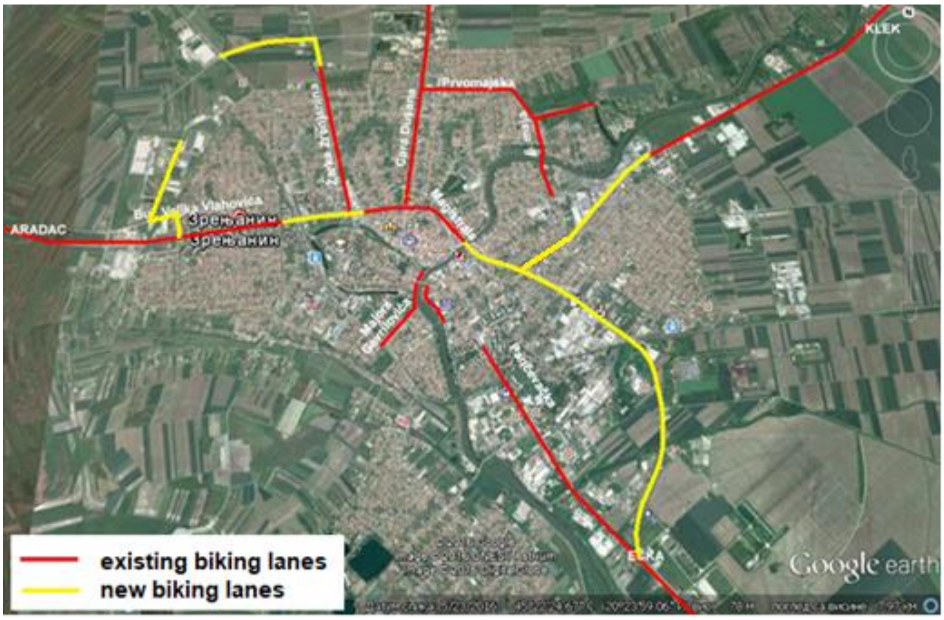


Figure 17. *Existing and newly designed biking lanes in Zrenjanin*

Figure 18. *The appearance of cycling lanes in Zrenjanin*

Another measure planned to be meet in Optimistic Scenario is introduction of the concept "Zone 30" (Streets planned to be covered by Zone 30 are shown on figure 19.). Zone 30 is designed in the central part of the town, creating a friendlier environment for pedestrians, cyclists and the local residents (the entire central city zone is shown in Figure 2 in red). Due to reduced speed of cars, other road users receive more freedom in their mobility. On the narrow roads of the city center it would be hard to provide separate lanes for bicycles because of limited space and potential danger, but calmed traffic (down to 30 km/h or less) allows both cars and bicycles to use one street or lane.

Figure 19. *The extra (red) and first zone (orange) of the urban zone on which the Zone 30 is planned to be introduced*

Figure 20. *Solution of marking Zone 30 together with cycling lanes on narrow streets in Netherlands*

Start of the implementation of a bike-sharing service in Zrenjanin is planned. At the beginning of the implementation it is foreseen to set up 3 bike share system, of which 2 would be located within bus stops and one in the pedestrian zone in the city center.

Figure 21. *Location of bike sharing system*

Figure 22. *Location of planned bike sharing system no.1*

Figure 23. *Location of planned bike sharing system no.2*

Figure 24. Location of planned bike sharing system no.3

Figure 25. *Appearance of bike sharing system along with a bus stop in New York*

Figure 26. *Appearance of bike sharing system along with a bus stop in China*

So, in the optimistic scenario selected measures are:

- The bike sharing service which provides short term bicycle rental at unattended stations: anyone can pick up a bike in one place and return it to another.
- Bus network - Redesigning the network layout of public transport by extending the service as well as by improving bus stops, stations, etc.
- Walking / cycling network - enhancing the quality and/or convenience of walking and bike trips through improved infrastructure (e.g. extension of cycling reserved lanes).
- Integrated ticketing systems means seamless travels and no requirement to buy tickets whilst switching either transport modes or services. Tariff schemes can be revised to attract more public transport passengers.
- Prioritizing public transport by improving the commercial speed of public transport vehicles, thus improving the service reliability and attractiveness to the general public, priority lanes etc.
- Traffic calming measures consist of various design features and strategies intended to reduce vehicle traffic speeds and volumes and so improve road safety. These measures can range from minor modifications of an individual

street, or comprehensive redesign of the road network in specific areas (i.e. "30 Zone"), to the concept of 'shared space' (under the principle that all transport modes must share the given street space).

The selected group of measures is aimed at promoting and popularizing pedestrian, bicycle and the use of public transport which are currently insufficiently used in Zrenjanin. Planning the expansion of pedestrian and bicycle infrastructure as well as the introduction of the bike share system would lead to a significantly higher percentage of their use (which is shown by the results below), and the City of Zrenjanin has very favorable conditions for these measures.

The way public transport will be more attractive to people is to make it more accessible, more regular and more reliable for all its users (not only for workers and trips for school). Also, ticketing system should be arranged so there is no requirement to buy tickets whilst switching either transport modes or services. A good measure is to prioritize public transport by improving the commercial speed of public transport vehicles which will improve its attractiveness which is predicted by this optimistic scenario.

All the mentioned measures should be considered to elaborate when developing the SUMP because of the great influence on the results which are shown below.

The following implementation aspects linked to the specific measures should be taken into account[6]:

• Traffic calming interventions can be very different in nature. Some are basically only a matter of regulation (e.g. setting speed limits) others require some civil engineering work and some investment. The budget for the whole roadmap should be carefully considered.

• Public transport ticket prices can be a powerful instrument to attract demand but attractive tariffs may not be economically viable for public transport operator in terms of revenues. Financial support to the transport operator might be needed.

• Integrated ticketing cannot be planned or decided at the urban level alone. The cooperation of regional operators and probably of urban operators of other cities is needed. A single city can stimulate the other institutions but cannot proceed independently.

• Effective measures to prioritize public transport can reduce space for cars (e.g. if parking lots curbside are removed to build a reserved lane) and generate local congestion. The same applies to cycling lanes. Especially at an early stage, when most of the trips are made by car, interventions can be unpopular.

[6]Study On European Urban Transport Roadmaps 2030, Urban transport policy roadmaps, March 2016, C.de Stasio, D.Fiorello, F. Fermi, G.Hitchcock, S.Kollamthodi

• Bike sharing schemes are generally characterized by low profitability and therefore might need to be subsidized by the municipality. To increase revenues, bikes might be customized for displaying advertising messages of private clients who pay for the publicity.

• The effectiveness of bike sharing depends on several practical conditions, e.g.:

- stations and bikes are well maintained;
- system easy to understand;
- various types of registration offered;
- combination and synergies with PT;
- fees structured to encourage use for short trips;
- effective redistribution systems to redistribute bikes.

Figure 27 shows ratio between cars and thousand inhabitants per years for optimistic scenario. On figure there are two lines, one (darker) represents the values in optimistic scenario while the other (lighter) represents the values in pessimistic scenario. Result is that, for optimistic scenario, in **2017** the motorization rate is 220. Results are showing that the motorization rate is 19% lower than in the pessimistic scenario, which is justified in Figure 28, which shows the percentage participation of passenger cars, which is by more than half that less than in the initial scenario.

Forecasted number in **2020** is 223 and in **2030** is 265 passenger cars. Observing this scenario in relation to the previous moderate scenario, there is a significantly lower motorization rate. If specific measures were implemented in the optimistic scenario, the expected motorization rate in 2030 would be 11.0% lower than for the same period in the moderate scenario.

Although passenger car participation in Modal Split is reduced, it can be expected that with the rise in population standards, the motorization rate will increase, bearing in mind that the Republic of Serbia is in the process of economic development. This should not be understood in such a way that residents of Zrenjanin will use passenger car for the purpose of moving around the city (the purpose of going to work or some other), but for the purpose of leaving the city for a weekend, on vacation or for other purposes not related to basic purposes movements in the urban area. This is in accordance with the statistics of development of Motorization Rate in the European Union. A graph showing the motorization rate in the EU for the period 1990-2016 is given below (source: https://www.statista.com/statistics/452238/europe-eu-28-number-of-cars-per-1000-inhabitants/).

The tool use impact on car ownership simulated at EU level in the HOP! Project (Macro-economic impact of High Oil Prices) (2008) as a reference to estimate the alternative trend.

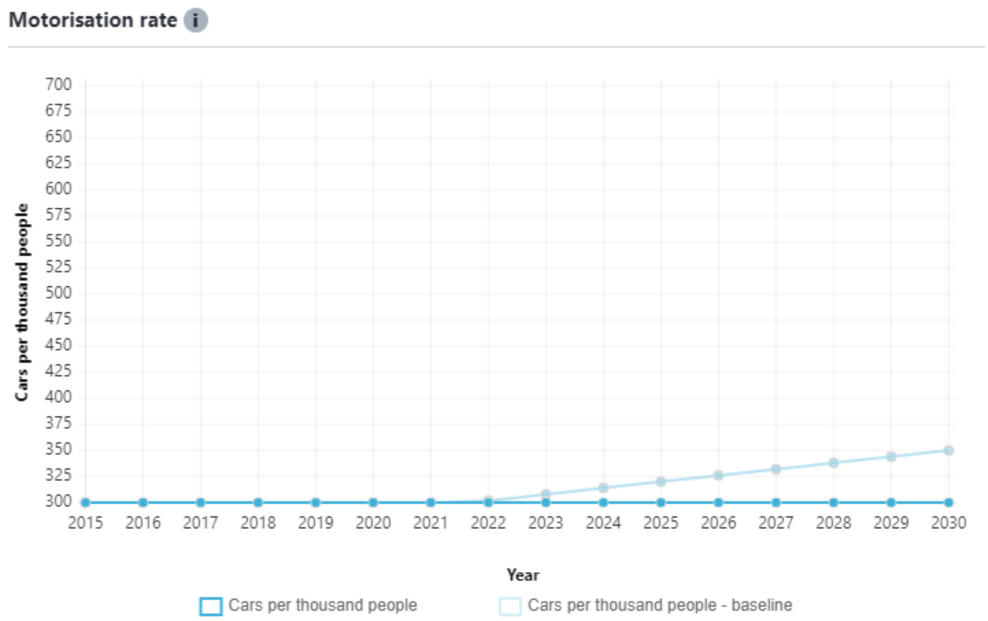


Figure 272.*Motorization rate, in terms of ratio between cars and thousand inhabitants per years for optimistic scenario*

Figure 28 shows in a parallel, values of mode split for the base-pessimistic and optimistic scenario, so it is easy to spot a significant difference between them. From It is noticeable that in **2017** the largest share in modes of transport is by pedestrians and public transport for all foreseen years. Projections are that in **2020** the percentage of pedestrians will be 43.7%, cyclists 13.2%, motorists 2.7% cars 17.5% and buses 22.9%, which is a significant decrease in the number of passenger cars and an increase in the number of pedestrians, cyclists and the use of public transport. It is even more noticeable that number are getting much better in forecasted **2030**, when it is predicted that the percentage of pedestrians will be 43.8%, cyclists 17.0%, motorists 1.4% cars 11.1% and buses 26.7%.

In this optimistic scenario, it is envisaged that by 2030, percentage of passenger cars will decrease by 8.8% observing the base year. When comparing the optimistic and pessimistic scenario for the target 2030-year percentage of passenger cars will decrease by 39.8%, the percentage of pedestrians increases by 15.2%, by cyclists by 16.0%, and percentage of using public transport would be higher by 8.2%.

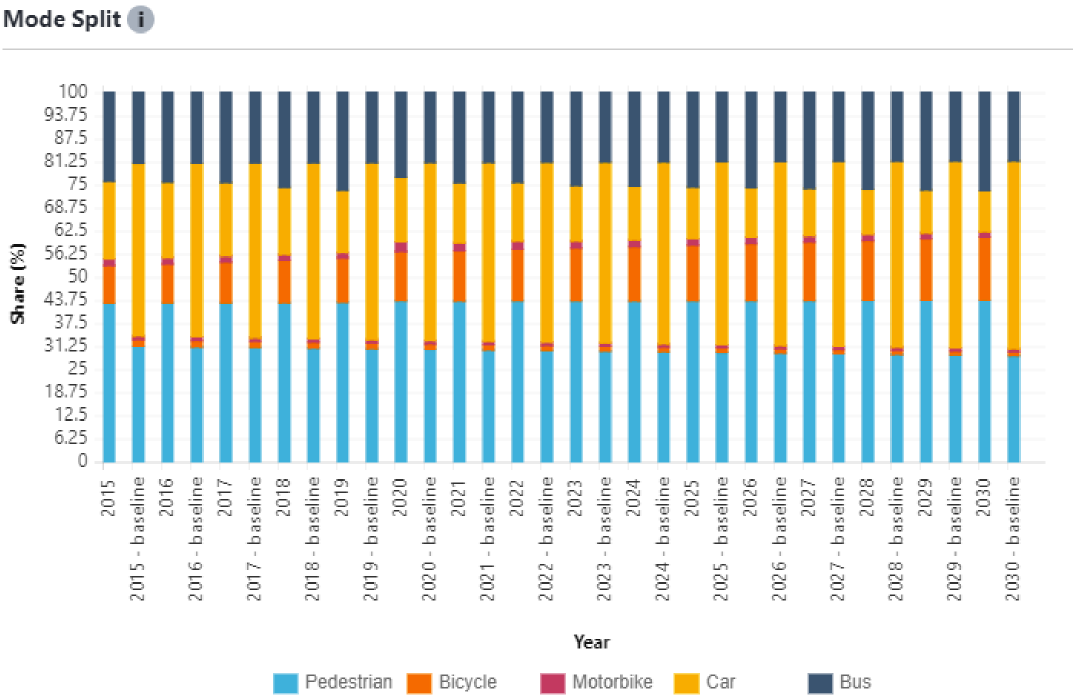


Figure 28. *Percentage share of each mode of transport per years for optimistic scenario (comparing with data for basic – pessimistic scenario)*

It is expected that planned measures give results in case of decreasing the portion of PA within overall city traffic. Related to the foreseen increase of PA, next figure clearly shows that it is not expected the PA will be used for city driving and meeting of basic need such as work, recreation, etc. Figure 29. shows traffic volume in terms of vehicle-km of passenger cars with conventional fuel (diesel, gasoline) traveling on the road network of the city. Graphic shows that vehicle-km is decreasing by 58.0% for the observed period.

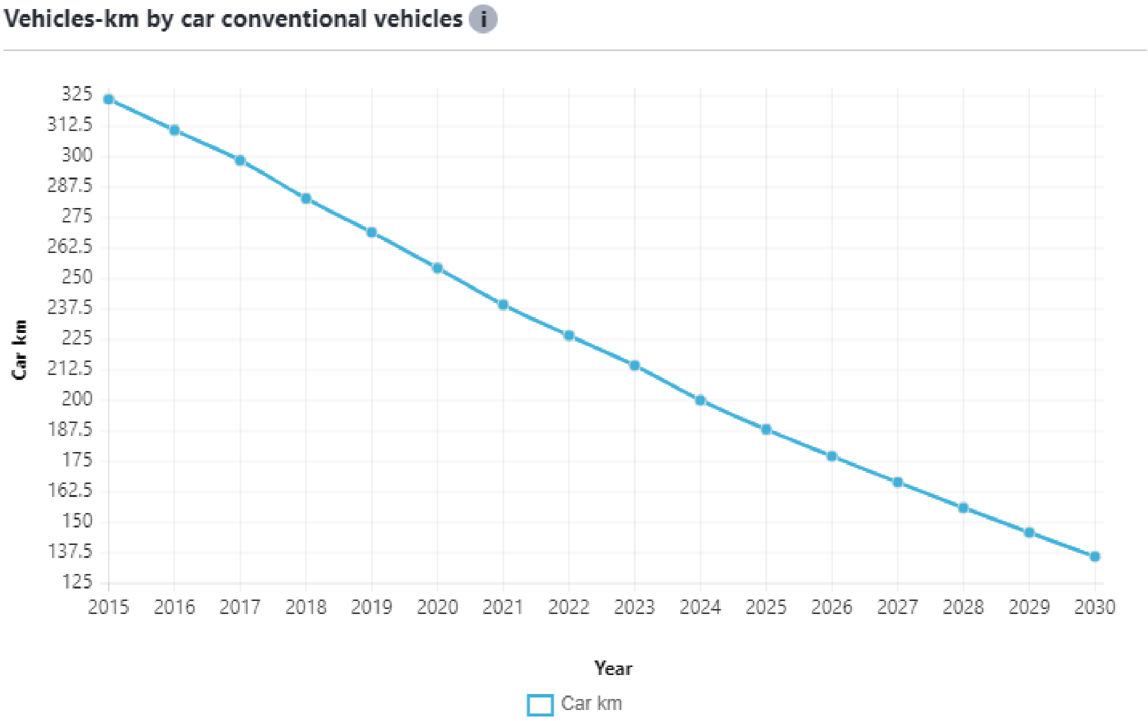


Figure 29. *Traffic volume in the Zrenjanin*

The improvement rate for gasoline, diesel, CNG and LPG vehicles is therefore about -2.6 / -3.0 % per year, while for innovative vehicles a growth rate of about -0.8 % / -1% per year is implemented (Source: Study on Urban Transport Roadmaps 2030).

An overview of current and predicted fuel consumption by type for optimistic scenario is shown in figure 30. It is noticeable that decrease in the consumption of diesel and gasoline fuel shall occur both in the optimistic scenario over the years and in relation to the base year (pessimistic scenario) and to a great extent. Forecasts are that in **2017**, the consumption of the diesel is 8481.5 tons per year, gasoline 9205.8, LPG 430.6 and hydrogen 0.019. In **2020**. the consumption of the diesel will be 7096.8 tons per year, gasoline 7956.6, LPG 340.0 and hydrogen 0.017. In **2030.** the consumption of the diesel will be 3964.4 tons per year, gasoline 4003.2, LPG 141.1 and hydrogen 331.4 (*Figure 29*). The savings in diesel are 53.3% and in gasoline are 56.5% for the period from 2017 to 2030 (only optimistic scenario observed).

Total fuel consumption by fuel type

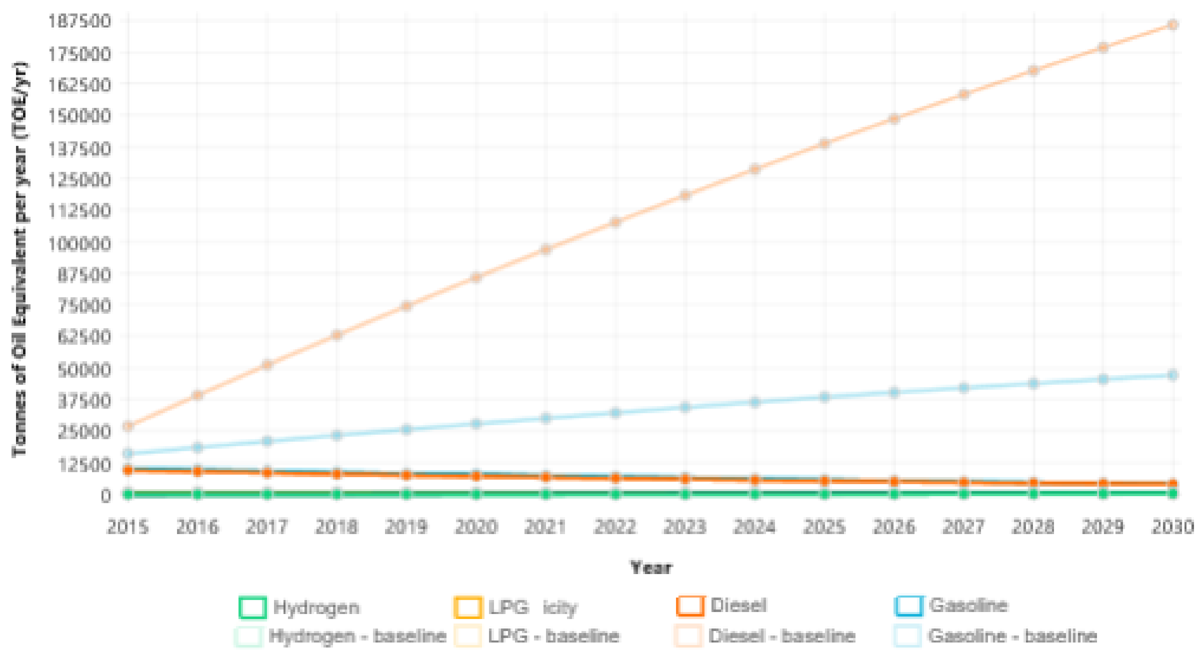


Figure 3. *Total yearly transport fuel consumption by fuel type (both internal mobility and incoming trips are considered) per years for optimistic scenario (also showing data for basic – pessimistic scenario)*

Figure above shows in a parallel, values of total fuel consumption for the base-pessimistic and optimistic scenario, so it is easy to spot a significant difference between them. It is envisaged that if the all measures are adopted, by 2030, percentage of fuel consumption will decrease for diesel by 97.8% and gasoline by 91.5%.

Data about emission of CO_2, in 2017, is 56629.2 tons, in 2020, emission of CO_2 will be 48399.2 tons and by 2030, emission of CO_2 will be 26788.1 tons. The Co2 emission graph is shown below on figure 31 and shows the values for an optimistic scenario (darker color) and a basic - pessimistic scenario (brighter color).

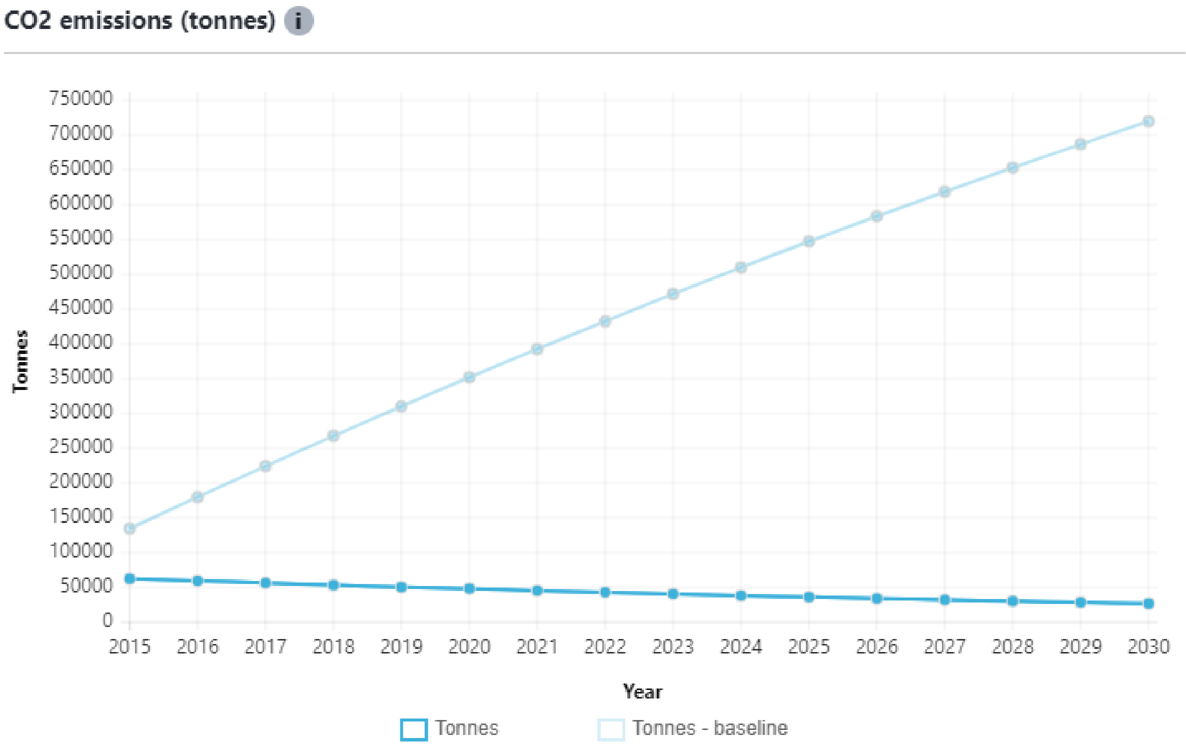


Figure 41.*Transport yearly CO2 emissions (a pessimistic and optimistic scenario is shown)*

It is predicted that by 2030, emission of CO_2 will decrease by 29841.1 tons, compared to 2017 year (52.7%). Also, a significant reduction in the CO_2 emission relative to the one that would be in the pessimistic scenario (for the same year) is envisioned. Savings in emission, for 2030 year is 692756.8 tons or 96.3%. These differences are best shown in the figure above.

5. Campaigns

As one important step, the promotion of sustainable forms of traffic should not be omitted, and in relation to walking, cycling and using public transport. This is a step that comes after implementation of the envisaged measures.

Example of good promotion of a cycling is in Munich, city of Germany[7]:

- The city was organized a large evening bicycle tour on the roads
- A bicycle safety check (including the bike safety joker);
- Bicycle fashion shows;
- A cycle star casting contest - a participation campaign with online-voting;
- A photoshoot;

[7] ELTIS; www.eltis.org

- Bicycle exchange markets;
- Bicycle exhibitions;
- School activities like a 'check your bike' programme, a bike quiz show, the creation of a bicycle campaign song;

The approach is always to inform and to create more understanding for all traffic participants in order to achieve a sense of togetherness rather than competitiveness on the roads.

Public transport promotion included[8]:

- Public events
- Workshops with students and seniors
- Exhibitions (history and development of PT in the city)
- Competitions (promotional video, history of PT)
- Training activities (training bus for children, education materials for traffic court)
- Promotion in local media
- Promotional PT vehicles with free WIFI

Public transport information brochures include:

- General information
- Information about touristic lines
- Information about night lines
- Information about PT in the city center
- Information about barrier-free access routes to PT

[8] CIVITAS; Measure 39, Public Transport Promotion Campaign, K. Oktabcova, 2012

6. Summary

Indicator	Pessimistic scenario (2017)	Moderate scenario (2017)	Optimistic scenario (2017)	Pessimistic scenario (2030)	Moderate scenario (2030)	Optimistic scenario (2030)
Motorisation rate	272	245	220	350	298	265
Mode split (%)	Car: 47.4% Bus: 19.1% Bike: 1.7% Motorbike:0.9% Walk: 30.9%	Car: 37.0% Bus: 30.2% Bike: 3.2% Motorbike:1.0% Walk: 28.6%	Car: 19.9% Bus: 24.4% Bike: 11.1% Motorbike:1.7% Walk: 42.9%	Car: 50.9% Bus: 18.5% Bike: 1.0% Motorbike:0.9% Walk: 28.6%	Car: 29.8% Bus: 33.6% Bike: 7.4% Motorbike:0.6% Walk: 28.6%	Car: 11.1% Bus: 26.7% Bike: 17.0% Motorbike:1.4% Walk: 43.8%
Average bus speed in peak hours (km/h)	13.4	17.8	18.8	10.7	19.9	20.4
Vehicles-km by car conventional vehicles	413.306	351.310	323.625	291.427	203.998	136.032
Total fuel consumption by fuel type (tons per year)	49940.0 diesel 20623.9 gasoline 0.065 hydrogen	10354.9 diesel 11466.0 gasoline 0.060 hydrogen	8481.5 diesel 9205.8 gasoline 0.019 hydrogen	181347.4 diesel 45745.5 gasoline 12.86 hydrogen	49940.0 diesel 8136.6 gasoline 10.1 hydrogen	3964.4 diesel 4003.2 gasoline 331.4 hydrogen
CO_2 emissions per year (tonnes)	219295.4	69581.2	56629.2	701159.9	45991.1	26788.1